

REMARKS

After careful review of the Office Action outstanding in this application, applicants have amended claims 1, 3, 5 and 7, to more clearly distinguish them over the art, and have added new claims 17-30 to provide the scope of protection to which they are believed entitled.

The present invention relates to a novel technique for producing unidirectionality in semiconductor photonic devices such as ring lasers and V-shaped lasers, based on the use of an etched gap or gaps in the laser waveguide. Such a gap enhances the side-mode suppression ratio of such lasers. The invention is further directed to the use of facets at or near the Brewster angle on photonic devices to prevent back-reflection.

In a preferred form of the invention, semiconductor lasers incorporate at least one gap which is provided by etching through the cavity of a ridge-type ring or V-shaped laser integrally fabricated on the surface of a substrate. In another embodiment, gaps may be etched in spaced-apart pairs, with the waveguide segment between the gaps being offset to compensate for reflection at the etched facets. In another form of the invention, when the laser output is coupled to a photonic device, back-reflection is minimized by providing a facet at the Brewster angle at the distal end of the photonic device.

In the Office Action, claims 1-4 were rejected under 35 USC 103 as being unpatentable over O'Brien et al. (5,793,521).

Claim 1 clearly distinguishes over the reference in reciting a gap in the laser cavity, for no such feature is found in O'Brien. However, in order to advance the prosecution of this application, claim 1 has been amended to emphasize that the etched gap recited in the claim extends through the semiconductor laser cavity of the claimed laser device. No suggestion of such a feature is found in the O'Brien reference, for the only gaps, or slots, mentioned in that reference are on top of the cavity, not in it. As pointed out in the specification of the present application, the etched gap is provided for the purpose of improving the side-suppression mode and the unidirectionality of the cavity, and no such function is described, or even suggested, in the O'Brien reference. Accordingly, since the reference teaches neither the structure nor the function of the claimed invention, it is clear that the reference cannot teach, nor does it suggest, the invention, as is required under 35 USC 103.

More particularly, O'Brien is said in the Office Action to teach a "gap 91", referred to at Column 8, line 64. However, it is respectfully pointed out that "91" in O'Brien is a resistive segment (Column 8, line 4, Fig. 9) which "may be insulative material or implanted material in the amplifier region". The purpose of the resistor is to vary the effective current density along the length of the amplifier.

As pointed out at Column 8, line 58+ of O'Brien, one way to add resistance and to keep the current density lower is to "add contacts 137 separated by slots 135 along the length." The "etched slots 135 or other resistive regions, such as those formed by implants, keep the currents...separate down the waveguiding layers so that different current densities are injected." Fig. 16 illustrates the slots 135 between electrodes 137 on the top of the laser cavity.

It is clear from the descriptions and illustration in O'Brien that the reference utterly fails to suggest an etched gap in a laser cavity segment, as is recited in claim 1. The only "gap" in O'Brien is a slot between electrical contacts on top of a waveguide. Further, the "gap" in O'Brien merely serves to distribute the current supplied to the waveguide, and does not provide the enhanced side-mode suppression ratio that applicants' structure achieves. Clearly, then, the reference fails to teach or even suggest the present invention, as claimed.

The foregoing distinctions over the reference are enhanced by the present amendment, wherein claim 1 has been revised to recite a gap that extends through the laser cavity segment. Clearly, no such structure is found in O'Brien, nor would it be obvious from the teachings of the reference to provide such a structure. Claim 1, as amended, is therefore clearly patentable.

Claims 2-4 are dependent on claim 1 and define over the reference for the reasons given above. Furthermore, there is no suggestion that the gaps might have the dimensions recited in claim 3. Contrary to the assertion of the Office Action, there is no teaching in the reference itself that would support the supposition that if there were a gap, it would have a length of between .001 and 10 micrometers. Certainly the specification at Column 8, lines 5-10 of O'Brien does not say this, and accordingly the rejection is based on mere conjecture.

Claims 5 and 7-12 have been rejected as unpatentable over O'Brien in view of Spitzer under 35 USC 103. Spitzer is cited for a teaching of the use of a facet at the Brewster angle.

It is respectfully pointed out that Spitzer provides no teachings of a gap in a laser

cavity, nor does it suggest the function of such a gap. Since Spitzer fails to teach the features which O'Brien lacks, as discussed above, the combination of these two references cannot possibly result in the claimed invention.

With respect to claim 5, Spitzer's teaching of a ring laser adds nothing to O'Brien that would result in the claimed ring laser with a gap.

With respect to claims 7 and 10, the assertion that Figs. 1 and 9 of O'Brien disclose a semiconductor laser cavity with "an etched gap located in the segment" simply is not supported by the actual teachings of that reference, as discussed above. The "gap" of O'Brien is in fact a slot between adjacent electrodes on the top surface of a waveguide. Therefore, the gap is not located "in" the segment. Accordingly, the premise on which the rejection of these claims is based cannot be supported by the references.

Even if it is admitted, for the purpose of argument, that Spitzer teaches "a facet (16) at the Brewster angle", the addition of such a facet on the device of O'Brien still would not produce, or even suggest, the claimed invention.

Claim 7 has been amended to recite an etched gap extending through the laser segment, and further distinguishes over the references, both singly and in combination.

Claims 8 and 9 are dependent on claim 7, and further distinguish for the reasons given above with respect to claim 2 and 3.

Claim 10 is an independent claim which recites a semiconductor photonic device having a cavity with one segment and an etched facet at or near the Brewster angle at one end of the segment. Although Spitzer is said to disclose a facet 16 at the Brewster angle, it discloses cleaved facets; it does not disclose the claimed "etched" facet.

Accordingly, the claim is clearly distinguished from the reference.

Claim 11 and 12 are dependent on claim 10, and distinguish over the references for the same reasons.

Claim 6 has been rejected under 35 USC 103 as unpatentable over O'Brien in view of Zoll (5,848,090), it being said that Zoll discloses a V-shaped laser.

Claim 6 is dependent on claim 1, which clearly distinguishes over O'Brien in reciting a gap. Zoll does not disclose the claimed gap, and thus cannot add to O'Brien one of the main features which distinguishes the claim over the references. In view of this failure of Zoll, claim 6 is clearly patentable.

Claims 13-15 have been rejected under 35 USC 103 over O'Brien in view of Spitzer and Zoll.

Claims 13-15 are dependent on claim 10. The mere fact that the laser of Zoll is V-shaped does not make it obvious to make any of the embodiments of O'Brien into a V shape. The O'Brien patent discloses numerous shapes and configurations, but nowhere does it suggest that any of them should be V-shaped. The purpose of O'Brien is to provide a differentially pumped semiconductor device, and nowhere does O'Brien suggest that this purpose can be accomplished by making it into a V shape.

Zoll does not suggest that a differentially pumped semiconductor device could be improved (or even would be operable) if made in a V shape, so there is no motivation in either O'Brien or Zoll to make the combination suggested in the Office Action. In the absence of a clear teaching in the art, the only basis for the asserted combination is applicants' claims, and that is not a permissible basis for a holding of obviousness. Accordingly, claim 13 is clearly patentable over the asserted combination of the

references.

The rejection of claim 14 is based on the assertion that "if" the laser of O'Brien were made in a V shape, the etched facet of O'Brien would be the Brewster angle, and then, it is further asserted, the Brewster angle "would" be at an end of the first leg.

There is obviously no support in the references themselves for such a speculative combination of references. The only basis for even suggesting such a combination is applicants' disclosure and claims, for certainly the references themselves do not support these assertions. As noted above, the "if" assertion is not supported in the references, and clearly there is no basis for the assertion that such a non-viable structure "would" have a Brewster angle facet at any particular location.

Accordingly, it is respectfully submitted that claims 13-15 are clearly patentable over the asserted combination of references.

The allowability of claim 16 is noted with appreciation.

New claims 17 and 18 are dependent on claim 5, and further define multiple etched gaps, each of which extends through the cavity segment. Since the prior art fails to disclose a single gap, it clearly cannot teach multiple gaps.

New claims 19-24 are dependent on claim 1, and distinguish over the art for the reasons already discussed. Furthermore, claim 19 recites multiple gaps, claim 20 defines the gaps as being spaced apart by a length of the cavity segment, claim 21 defines the length of the gaps, claim 22 defines perpendicular facets for each gap, claim 23 defines angled gap facets, and claim 24 defines an offset length of the cavity between adjacent gaps. Each of these claims thus further defines over the base claim 1, in reciting additional features not found in the cited references. Accordingly, these

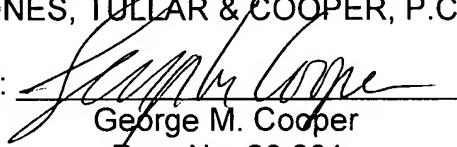
claims are believed to be clearly allowable.

New Claim 25 is an independent claim which defines a waveguide cavity having entrance and exit facets and an etched gap extending through the cavity between the entrance and exit facets. This structure is clearly distinct from the references relied on in the Office Action for the reasons given above with respect to claim 1. The claim defines the gap as comprising parallel etched facets spaced apart by about 0.001-10 micrometers. These features further define over the references for the reasons given above.

Claims 26-30 are dependent on claim 25, and add features such as multiple etched gaps (claim 26) and angled gaps (claim 27) and which define a ring laser (claim 28) and a coupled photonic device (claim 29). Claim 30 defines the coupled photonic device as V-shaped with a distal facet at the Brewster angle. As discussed above, none of these features are suggested by any combination of the references of record.

In view of the foregoing, it is clear that the claims now in this application are patentably distinct over the references, and favorable reconsideration is solicited.

Respectfully Submitted,
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